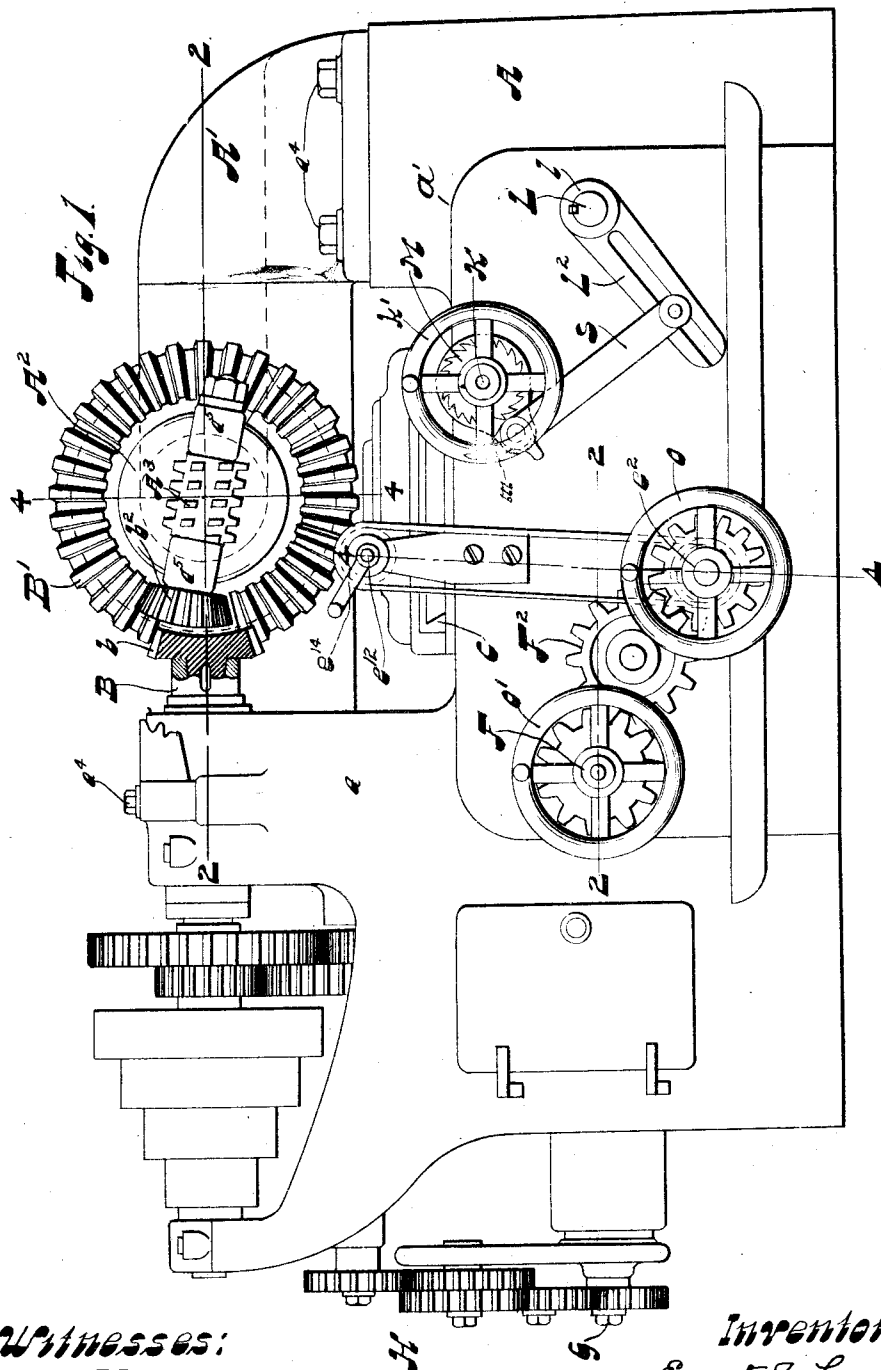


E. J. LEES.
 GEAR CUTTING MACHINE.
 APPLICATION FILED SEPT. 21, 1906.

Patented June 24, 1913.

4 SHEETS—SHEET 1.

1,065,817.



Witnesses:
 Edw. Lindmüller.
 E. M. Saywell

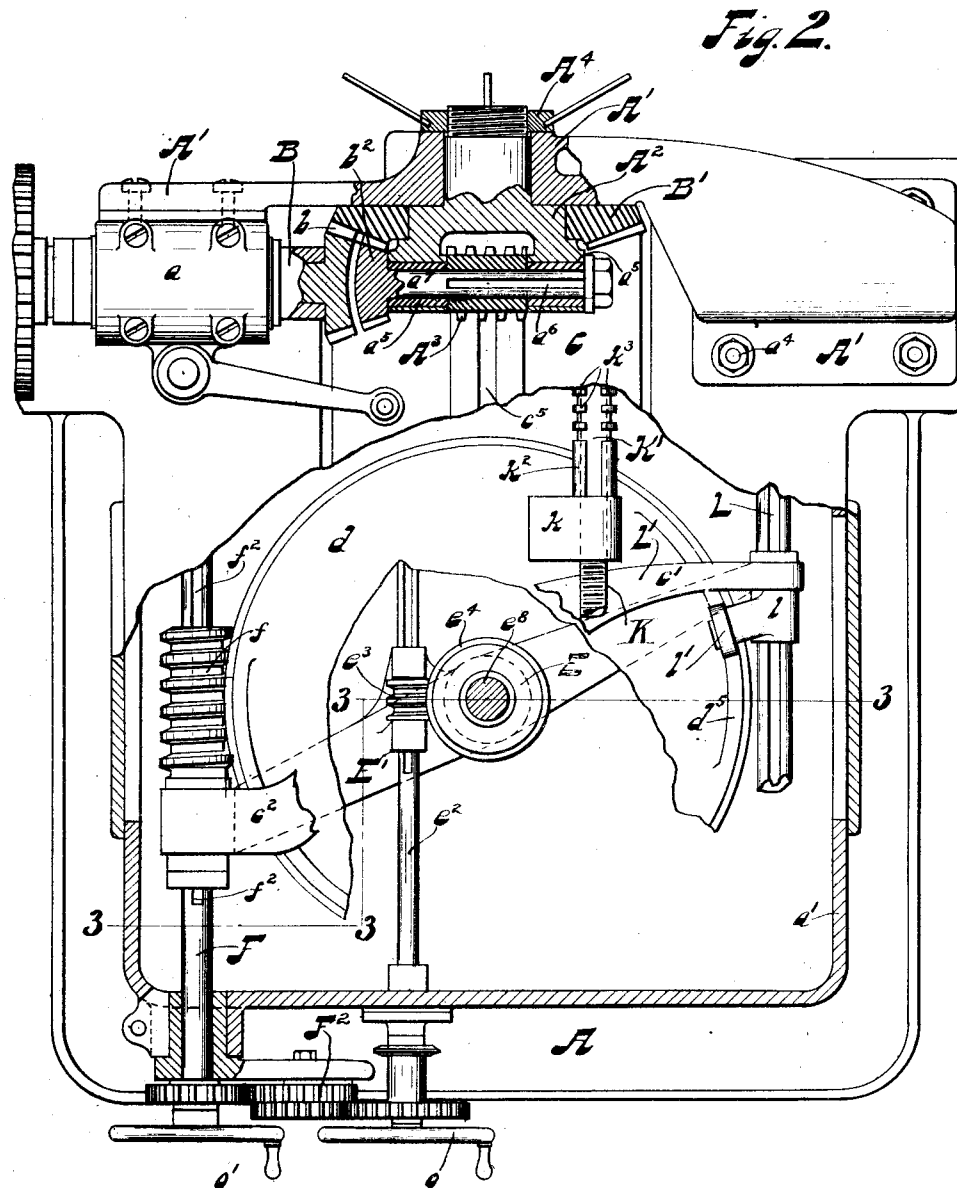
Inventor:
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 His Attorney.

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4 SHEETS—SHEET 2.



Witnesses:
Edw. Lindmuller.
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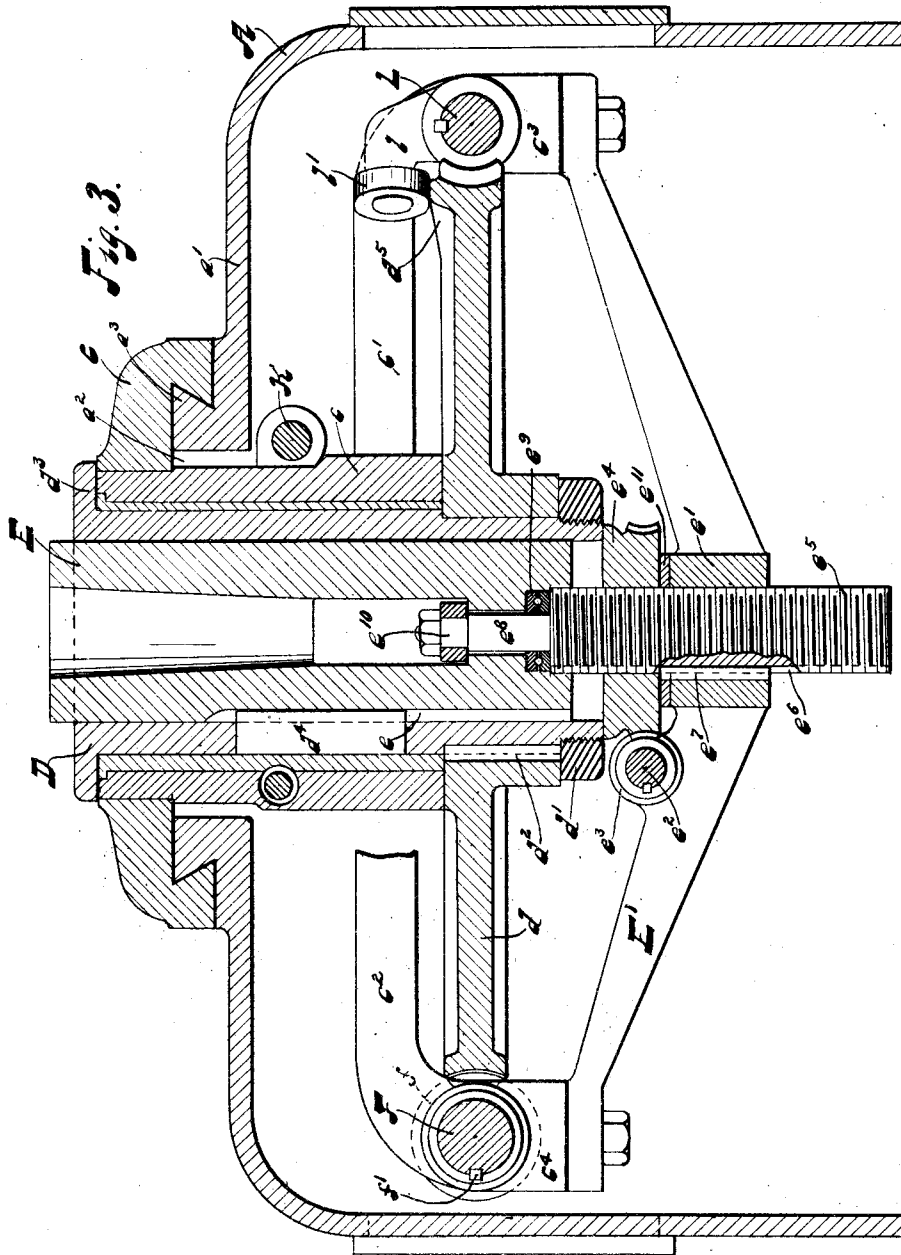
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4 SHEETS—SHEET 3.



Witnesses:
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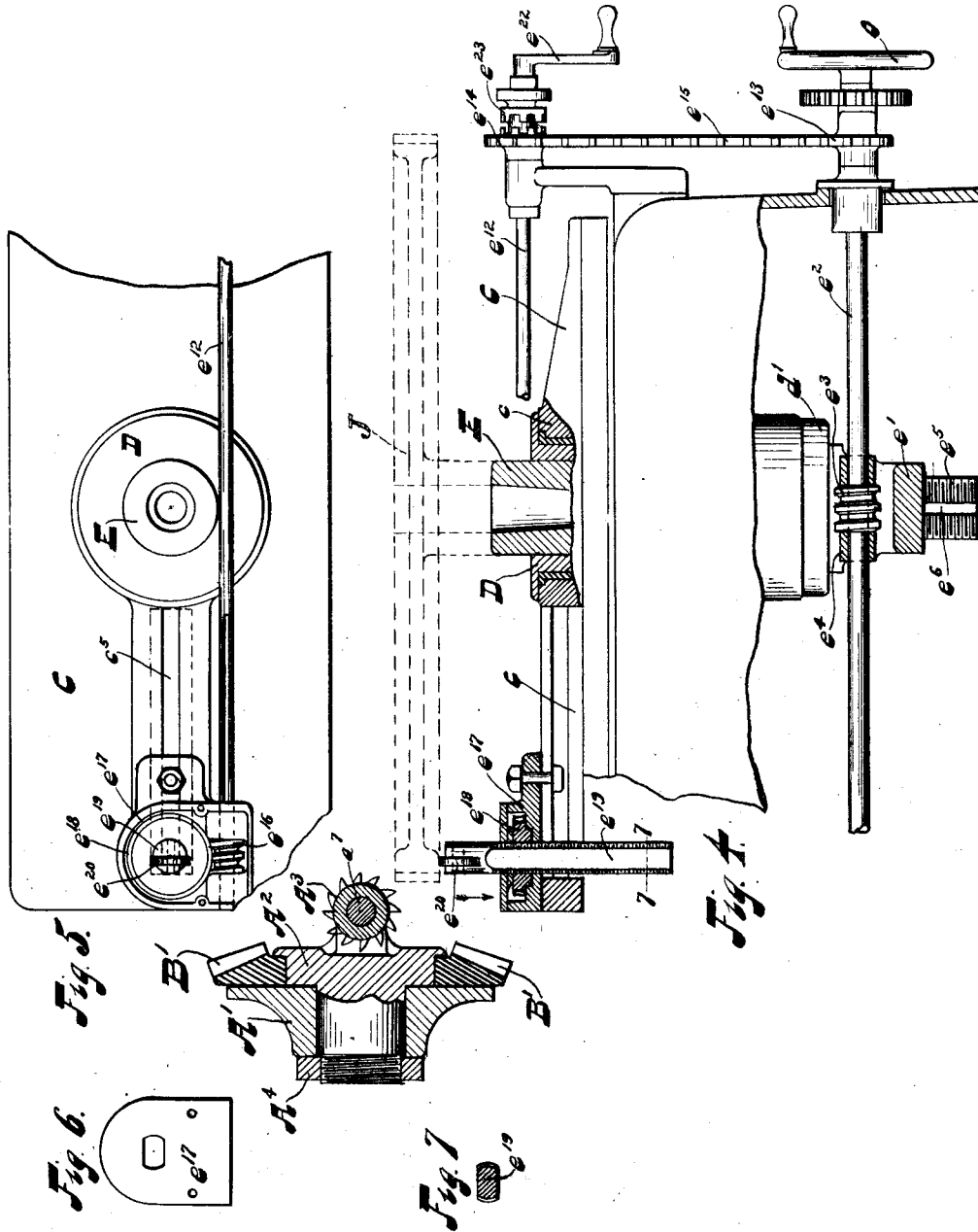
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4 SHEETS—SHEET 4.



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Edw. Lindmüller,
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UNITED STATES PATENT OFFICE.

ERNEST J. LEES, OF CLEVELAND, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO
GOULD & EBERHARDT, OF NEWARK, NEW JERSEY, A CORPORATION OF NEW
JERSEY.

GEAR-CUTTING MACHINE.

1,065,817.

Specification of Letters Patent. Patented June 24, 1913.

Application filed September 21, 1906. Serial No. 335,565.

To all whom it may concern:

Be it known that I, ERNEST J. LEES, a citizen of the United States, resident of Cleveland, county of Cuyahoga, and State of Ohio, have invented a new and useful Improvement in Gear-Cutting Machines, of which the following is a specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle, so as to distinguish it from other inventions.

My invention relates to mechanism for cutting gears and especially to attachments and modifications adapted to be applied to a worm-wheel-cutting machine whereby the latter can be used as a spur and spiral gear cutter.

Said invention is particularly designed to be an improvement upon the worm-wheel-cutting machine shown and described in United States Letters Patent No. 684,634, issued Oct. 15, 1901, to John J. Grant, and consists of the apparatus hereinafter fully described and particularly set forth in the claims.

The annexed drawings and the following description set forth in detail certain mechanism embodying the invention, such disclosed means constituting but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawings:—Figure 1 is a front elevation of the machine, a small pinion secured to the live-spindle and a small portion of the latter being shown in section; Fig. 2 represents broken horizontal sections taken upon the planes indicated by the lines 2—2, Fig. 1; Fig. 3 represents vertical sections taken upon the planes indicated by the lines 3—3, Fig. 2; Fig. 4 is a broken vertical section taken upon the plane indicated by the line 4—4, Fig. 1, and at right angles to Fig. 3; Fig. 5 is a broken plan view of the carriage and some adjacent elements adapted to support the work-wheel; Fig. 6 is a plan view of the cover of the case containing the worm-wheel and the roller-supporting screw shown in Fig. 4; and Fig. 7 is a horizontal section of said screw, taken upon the plane indicated by the line 7—7, Fig. 4.

Upon one side of the frame A of the machine is provided a head-stock *a* in which is mounted the live-spindle B, and upon the other side of the frame is secured in suitable T-slots by means of bolts *a*⁴ a cross-member A' which extends across transversely of the machine and is bolted to the rear of the head-stock *a*. Upon the cross-member A' is carried a swiveling arbor-support A² provided with double bearings *a*⁵ between which is placed a hob A³ fastened by a suitable spline and key *a*⁶ to the arbor *a*⁷ journaled in the bearings *a*⁵. The swiveling arbor-support A² may be locked in position by a nut A⁴ upon its outer end which extends through the cross-member A'. Upon the end of live-spindle B is secured a bevel pinion *b* which meshes with a bevel idler B' which rotates on, around, and concentric with the swiveling arbor-support A². This bevel idler B' has a face wide enough to mesh with another bevel pinion *b*² by the side of the bevel pinion *b*, said pinion *b*² being secured to an end of the hob-arbor *a*⁷. The pinion *b*² is enough closer to the center of the swiveling arbor-support A² than the pinion *b* to allow said pinion *b*² to swing by the live-spindle pinion *b* without interference. The idler gear B' is always free to rotate since it is journaled in a space upon the swiveling arbor-support A² which is wider than the length of the hub of the gear B'.

The frame A is provided with a bed-plate *a*¹ within which is an opening *a*² extending lengthwise of the machine, and at the sides of this opening are the dovetailed ways *a*³ on which is mounted a carriage C adapted to slide toward and from the live-spindle B. Rigidly secured to the carriage C is a cylindrical barrel *c* which extends downwardly within the carriage. Within the barrel *c* is rotatably mounted a sleeve D, upon the lower end of which is threaded a nut *d*¹ and to the sleeve D is keyed a worm-wheel *d*. The latter meshes with a worm-sleeve *f* splined to a shaft F by means of a key *f*¹ carried upon sleeve *f* and a groove *f*² in shaft F. Sleeve *f* is thus rendered longitudinally movable of shaft F. Splined to

and longitudinally movable of the sleeve D is a vertically-movable spindle E adapted to support the work-wheel and feed the latter upwardly so that the teeth may be cut therein, as hereinafter fully explained. The shaft F is connected with the live-spindle B by suitable mechanism which will compel the worm-wheel d , the sleeve D and the spindle E to rotate once while the live-spindle B is rotating as many times as there are teeth to be cut in the spur-gear. The specific mechanism for effecting this connection is substantially the same as that shown and described for the same purpose in said Patent No. 684,634, including the shaft G and the change-gearing H.

An arm c^2 secured to the barrel c of the carriage C engages in a circumferential groove in the worm-sleeve f , whereby as the said carriage is moved along the worm-sleeve will be also moved upon the shaft F and maintain its proper relation with the worm-wheel d . The adjustment of the carriage C is effected by means of the feed-screw K passing through a threaded bracket k upon the under side of the carriage. This feed-screw K is turned by means of the hand-wheel k' when a spur or spiral gear is being cut, and the location of the carriage C is ascertained as follows before the cutting operation is commenced. Projections k^3 , Fig. 2, upon an adjustable sleeve K' which telescopes over the feed-screw K, represent definite distances, for instance, between each two contiguous projections k^3 might be the distance of one inch. The adjustable sleeve K' , and, consequently, the projections k^3 , are longitudinally movable of the feed-screw K, but can be turned so as to be fixed in a longitudinal position relatively to said feed-screw, all as is plainly shown and described in said Grant Patent No. 684,634. Now if, for instance, a gear of twenty-four inches diameter is to be cut and the hob is six inches in diameter, the stop k^2 is set at the pitch radius of the gear plus the pitch radius of the hob, i. e. at fifteen inches, and then the bracket k is set up against the stop k^2 by means of the hand-wheel k' , this action effecting the proper location of the carriage before the cutting is commenced. In such a use of the machine the spring-pawls m , Fig. 1, hereinafter described, are thrown out of mesh since the continuous feed of the carriage during the cutting is not utilized. However, the conversion of the worm-wheel-cutting machine to a spur and spiral gear cutter does not affect its function as a worm-cutter, since all the necessary elements of the latter are retained or replaced by elements effecting the same purposes. When thus used as a worm-wheel-cutting machine, the feed-screw K is turned automatically to effect the con-

tinuous feed of the carriage C by means of the following mechanism: A shaft L is mounted in the frame of the machine parallel with the feed-screw K. An arm l embraces the shaft L and is connected to it by a tongue-and-groove connection, which causes the arm and shaft to turn simultaneously but permits the arm to slide along the shaft. In the hub of the arm l is a circumferential groove which receives one end of an arm c' secured to the barrel c . This arm l extends over the worm-wheel d and carries a friction-roller l' which bears upon the top edge of said wheel d , which top edge has a cam or inclined surface d^5 by means of which the shaft L is periodically rocked. This shaft L has also a slotted arm L^2 which is connected by means of a link S to a pawl-carrier which carries a pawl m which is adapted to engage with a ratchet-wheel M frictionally secured to the feed-screw K. The work-wheel J in which the teeth are to be cut will preferably be secured to a mandrel having a tapered end which will be drawn into the tapered socket in the spindle E, as indicated by dotted lines in Fig. 4.

Projecting downwardly from the arms c' and c^2 and embracing the shafts L and F, respectively, but longitudinally movable thereof, are two pads c^3 and c^4 to which are secured the respective ends of a transverse member E' which has a centrally-located bearing e' concentric with the spindle E. This transverse member E' has suitable bearings for a splined shaft e^2 and a worm e^3 secured thereto. This worm e^3 meshes with a worm-wheel e^4 which is internally-threaded and fits upon a vertical screw e^5 which passes freely through the transverse member E' vertically but is not allowed to rotate, having a spline e^6 which runs the whole length of the threaded portion of the screw e^5 and is engaged by a fixed key e^7 in the central bearing e' . The vertical screw e^5 has upon its upper end a reduced portion e^8 which passes through the small bore of spindle E, there being provided a ball-bearing thrust-collar e^9 at the lower end, and a nut and collar e^{10} at the upper end, the upper collar being spaced at such a distance from the spindle E as to allow the latter to rotate freely.

The bearing e' of the transverse member E' is so located that there is just the necessary clearance between its upper face and the lower face of the sleeve D to allow the worm-wheel e^4 and a thrust collar e^{11} to fit in between and rotate. The splined shaft e^2 is geared to the shaft F by suitable mechanism F^2 , Fig. 2, that can be adjusted to feed the spindle E vertically at any desired ratio to the rotation of said spindle E. It will accordingly be seen that means are provided,

specifically mechanism F^2 , whereby the rate of feed of the blank across the hob may be varied as desired. At the same time it will be recalled that means are provided, specifically change speed gear H, whereby the relative rates of rotation of the hob and blank may be determined as desired. These means being all interconnected it will then be apparent that by suitable adjustment of such mechanism F^2 and change speed gear H the feed movement of the blank and the head of the hob, which the latter must be given in the cutting of the spiral gears, may be properly correlated. That this statement may be clearly comprehended I shall advert briefly to the operation involved in cutting first an ordinary spur gear with my improved mechanism above described, and then in cutting a spiral, or as it is sometimes termed, helical gear. If an ordinary spur gear, that is one having straight teeth, is to be cut, the hob, which may have teeth of any desired shape and pitch, is secured in the head at such an angle to the plane of the wheel to be cut as will compensate for the helical line on which the teeth of the hob lie. Change speed gear H is then arranged so as to effect as many revolutions of the hob to the one revolution of the blank as there are teeth to be cut in the latter. Upon the blank being now fed upwardly in a line parallel with its axis across the face of the hob the teeth across the whole width of the blank face will be cut in a direction parallel with the axis of the blank as is required for spur wheels. In thus cutting spur wheels the rate of feed of the blank thus across the hob is adjusted to give the best results, having in view the character of the material constituting the blank and without any regard to the relation of such feed to the relative rotative movements of the blank and hob. If now, however, it is desired to cut spiral teeth upon the blank while the feed of the blank is in the same direction and the rate of such feed is determined by the same consideration as before the relative rates of rotation of blank and hob are carefully correlated with such feed movement by proper adjustment of mechanisms F^2 , H. This for the reason that to cut spiral teeth the hob requires to be secured in the head at an angle to the plane of the blank, greater or less as the case may be, then the angle of the spiral by an amount equal to the angle of the teeth to be cut. The hob will accordingly, in its rotation, have to be given a lead either positive or negative, the amount of which lead for each fraction of the rotation will have to correspond, having due regard to the angle of the gear being cut, to the advance of the blank across the hob during the same time. The calculation of the gear connections involved in mechanisms F^2 , H, in order

to secure this correlation of rate of feed and relative rates of rotation so that the advance of the blank and the lead of the hob may be thus correlated for the cutting of any particular gear is rendered relatively simple by the use of suitable tables and need not here be taken up in detail.

Geared by suitable mechanism e^{13} , e^{14} , and e^{15} with splined shaft e^2 below is an upper splined shaft e^{12} which drives a worm e^{16} located in a case e^{17} which also contains a worm-wheel e^{18} , said case being cut through at its lower portion in order to allow a vertical screw e^{19} to pass down through but not rotate. This vertical screw carries a roller e^{20} upon its upper end which is used as follows: When a gear large enough to need support under the teeth being cut is mounted in the spindle E, the clutch e^{23} upon the end of splined shaft e^{12} is released from the driving gear e^{14} and the shaft e^{12} is turned by crank e^{22} until a sufficient pressure and support is obtained by raising the roller e^{20} under the edge of the gear. Then the clutch is forced back into mesh with the gear e^{14} and since the rates of vertical movement of the spindle E and roller e^{20} are arranged to be the same, the initial pressure that is obtained will be continued through the cutting of the gear. When the machine is utilized as a worm-wheel cutting machine, the hand wheel O is utilized to adjust the spindle E up or down, the live-spindle B being disconnected by a suitable clutch (not shown) in the rear of the machine. When it is desired to manually position the worm-wheel d , this is effected by means of the hand-wheel O', Figs. 1 and 2. The case e^{17} is always located directly under the cutting edge of the hob A^3 and is adjustable horizontally in the slot c^5 , Figs. 2 and 5, along the carriage C to conform to the different diameters of different gears to be cut.

In order to adjust the spindle E and roller e^{20} simultaneously, the clutch e^{23} is continued in mesh with gear e^{14} , and the mechanism F^2 , Figs. 1 and 2, disconnected, and then the crank e^{22} adjusts both the spindle E and the roller e^{20} up or down.

The new attachments which I have provided and which are exemplified in the foregoing description and the accompanying drawings, by the mechanism for producing (1) the rotation of the hob-arbor a^7 at whatever angle it may be set, (2) the positive, automatic feed of the spindle E, and (3) the feed of the screw e^{19} and roller e^{20} at the same rate of speed as the spindle E, are not confined in their uses to a spur and spiral gear cutter, but may be applied as separate elements and attachments to other relations, such as a milling machine.

Having thus described my invention in

detail, that which I particularly point out and distinctly claim is:

1. In a machine for cutting gears, the combination with a rotary cutter and a blank-receiving spindle mounted in operative relation thereto; of means adapted to rotate said cutter and spindle at desired relative rates of speed; means adapted to move said spindle to carry the blank across said cutter; and means adapted to support the edge of the blank, and connected to be moved in unison with aforesaid means.

2. In a machine for cutting gears, the combination of a live-spindle; a sliding carriage movable toward and from said spindle; a vertical sleeve rotatably mounted in said carriage; mechanism for positively rotating said sleeve and the live-spindle at the desired relative speeds; a spindle in said sleeve; tongue-and-groove connections between said sleeve and spindle; mechanism adapted to positively feed the latter upwardly at a predetermined speed relative to said live-spindle; and means geared to the live-spindle, adapted to support the edge of the work-wheel, and adapted to be fed upwardly at the same rate of speed as the sleeve-spindle.

3. In a machine for cutting gears, the combination of a live-spindle; a sliding carriage movable toward and from said spindle; a vertical sleeve rotatably mounted in said carriage; mechanism for positively rotating said sleeve and the live-spindle at the desired relative speeds; a spindle in said sleeve; tongue-and-groove connections between said sleeve and spindle; mechanism adapted to positively feed the latter upwardly at a predetermined speed relative to said live-spindle; and means geared to said feeding mechanism in the ratio of one-to-one, adapted to support the edge of the work-wheel, and including a vertically-movable screw carrying a friction-roller adapted to engage with said work-wheel.

4. In a machine for cutting gears, the combination of a live-spindle; a sliding carriage movable toward and from said spindle; a vertical sleeve rotatably mounted in said carriage; mechanism for positively rotating said sleeve and the live-spindle at the desired relative speeds; a spindle in said sleeve; tongue-and-groove connections between said sleeve and spindle; mechanism adapted to positively feed the latter upwardly at a predetermined speed relative to said live-spindle; means geared to the live-spindle, adapted to support the edge of the work-wheel, and adapted to be fed upwardly at the same rate of speed as the sleeve-spindle; means adapted to disengage said supporting means from said live-spindle; and independent means adapted to vertically adjust said supporting means.

5. In a machine for cutting gears, the combination of a live-spindle; a sliding carriage movable toward and from said spindle; a vertical sleeve rotatably mounted in said carriage; mechanism for positively rotating said sleeve and the live-spindle at the desired relative speeds; a spindle in said sleeve; tongue-and-groove connections between said sleeve and spindle; mechanism adapted to positively feed the latter upwardly at a predetermined speed relative to said live-spindle; means geared to said feeding mechanism in the ratio of one-to-one, adapted to support the edge of the work-wheel, and including a vertically-movable screw carrying a friction-roller adapted to engage with said work-wheel; means adapted to disengage said feeding mechanism and said supporting means from said live-spindle; and independent means adapted to vertically adjust said sleeve-spindle and said vertical screw.

6. In a machine for cutting gears, the combination of a live-spindle; a sliding carriage movable toward and from said spindle; a vertical sleeve mounted in said carriage; a spindle in said sleeve; tongue-and-groove connections between said sleeve and spindle; a worm-wheel secured to the lower end of said sleeve; mechanism intermediate of said live-spindle and said worm-wheel whereby said live-spindle and said sleeve are rotated at the proper relative speeds; a cross-member; a screw mounted in said cross-member and longitudinally fixed at its upper end to said sleeve-spindle; gearing intermediate of said screw and said live-spindle and including a shaft journaled in said cross-member; a second shaft; one-to-one gearing connecting said two shafts; a worm carried by said second shaft and longitudinally movable thereof; an internally-threaded worm-wheel engaging with said worm; a vertical screw received by said worm-wheel; a case slidably mounted in said carriage, inclosing said worm and worm-wheel and provided with apertures through which said last-mentioned screw may pass; and a friction-roller mounted upon the top of said screw and adapted to engage with the under edge of the work-wheel.

7. In a machine for cutting gears, the combination of a live-spindle; an arbor rotated by the latter; mechanism for positively feeding the work-wheel toward said arbor; a screw carrying a friction-roller adapted to engage and support the edge of the work-wheel; and mechanism adapted to feed said screw toward said work-wheel at the same speed that the latter is fed toward said arbor.

8. In a machine for cutting gears, the combination of a live-spindle; an arbor ro-

tated by the latter; a vertical spindle adapted to carry the work-wheel; mechanism for positively feeding said spindle toward said arbor; a vertical screw carrying a friction-
5 roller adapted to engage and support the edge of the work-wheel; a worm-wheel geared to said spindle-feeding mechanism, internally threaded to receive said screw, and adapted to feed the latter upwardly at

the same rate of speed as the upward movement of said spindle. 10

Signed by me this 14th day of September 1906.

ERNEST J. LEES.

Attested by—

JNO. F. OBERLIN,
G. W. SAYWELL.